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(71)(72) Applicant and Inventor: WINN, Houston [US/US]; Box 1389, Splendora, TX 77372 (US).

(74) Agent: EGBERT, John, S.; Harrison & Egbert, 1018 Preston, Suite 100, Houston, TX 77002 (US).

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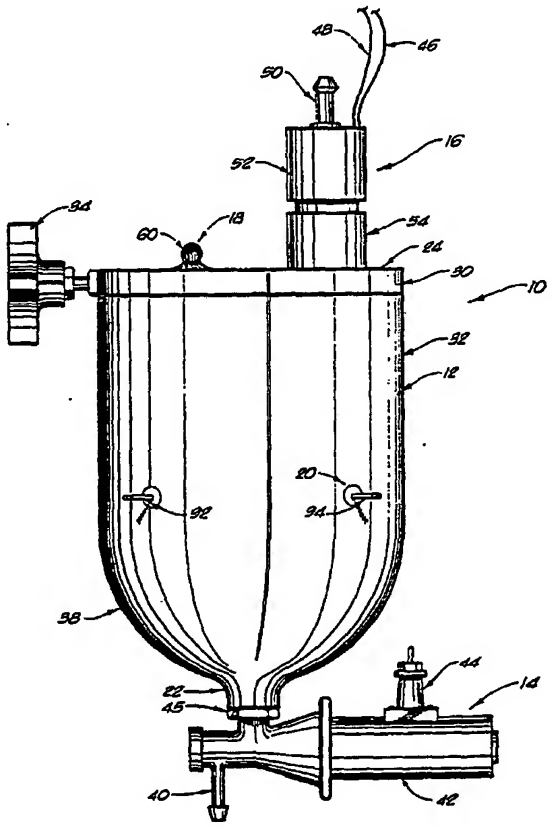
(54) Title: FUEL FILTER AND SEPARATOR

(57) Abstract

A fuel filter apparatus including a chamber (12), a discharge gate (14), a fuel pump (16), and a fuel filter. The discharge gate (14) is connected to the bottom of the chamber (12). The fuel pump (16) is connected to the top surface of the chamber (12) and is for controllably passing fuel into the chamber. The fuel filter is inside and connected to the top of the chamber (12). A water sensor (20) detects water within the chamber (12). The discharge gate (14) is remotely actuable and includes a nozzle (40) and solenoid-actuated valve (42).



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FUEL FILTER AND SEPARATOR

TECHNICAL FIELD

The present invention relates to an apparatus for the filtering of fuel in internal combustion engines. More particularly, the present invention relates to apparatus that separate air and water contaminants from fuel.

BACKGROUND ART

The diesel engine is an internal combustion engine that differs from the gasoline engine principally in that it relies on heat generated by compressing air in a cylinder to ignite the fuel, rather than on an electric spark. To generate the required heat, the diesel must produce higher compression than the gasoline engine, thereby making it bulkier, heavier and more expensive. The diesel engine also operates more cheaply, on less highly refined fuel, which can give it an advantage in transportation and construction-equipment applications such as locomotives, trucks, tractors, buses, bulldozers, graters, and other heavy-duty machines, and in marine propulsion.

Although two English engineers have patented engines that did not depend on spark ignition, Rudolf Diesel of Germany conceived his invention as an improvement on the gasoline engine that fellow-German Nikolaus Otto had developed in 1876. Seeking to increase the efficiency of the Otto engine, it occurred to Diesel that he could do away with electrical ignition if he could compress air to so small a volume that the temperature would be above the ignition point of an appropriate fuel. The cycle of operation he conceived was set forth as follows: (1) air is drawn into the cylinder as the piston moves away from the cylinder head (intake); (2) the air in the cylinder is compressed by the piston as it moves upward toward the cylinder head (compression); (3) when the piston reaches the top of its stroke, the fuel charge is injected into the cylinder, where it is ignited by the high temperature of the compressed air. The fuel is injected at such a rate that the maximum cylinder pr ssure never exceeds the pressure obtain d

by the compression of the air. After completion of the fuel injection, the piston continues to move away from the cylinder head in its downward or expansion stroke (power); (4) the burned fuel is forced from the cylinder by upward motion of the piston (exhaust).

In 1892-93, Diesel took out patents on an engine to operate on the cycle just described. Either powdered coal or liquid petroleum would be used as fuel. Diesel planned to use compressed air to introduce the coal dust into the engine cylinder but found it difficult to control the rate of injection so that the maximum pressure in the cylinder after ignition would not exceed a safe limit. After the experimental engine was wrecked by an explosion in the cylinder, Diesel gave up the idea of using the coal dust and devoted his efforts to the use of liquid petroleum.

The first commercial engine built on Diesel's patents was installed in St. Louis, Missouri by brewer, Adolphus Busch, who had seen one on display at an exposition in Munich and had purchased a license from Diesel for the manufacture and sale of the engine in the United States and Canada. The engine operated successfully for many years and was the forerunner of the Busch-Sulzer engine that powered many submarines in the U.S. Navy in World War I. The diesel engine became the major power plant for submarines during World War I. It was not only economical in the use of fuel, but it proved itself reliable under wartime conditions. Diesel fuel, less volatile than gasoline, was more easily stored and handled.

A diesel engine is started by driving it from some external power source until conditions have been established under which the engine can be run under its own power. The most positive starting method is by admitting air at 250 to 350 p.s.i. to each of the cylinders in turn under normal firing stroke. The compressed air becomes heated sufficiently to ignite the fuel. There are many other methods of starting the diesel engine. The selection of the most suitable starting method depends upon the physical size of the engine to be

started, the nature of th connected load, and whether or not the load can be disconnected during starting.

Petroleum products normally used as fuel for diesel engines are distillates composed of heavy hydrocarbons, with at l ast twelve to sixteen carbon atoms per molecule. These heavier distillates are taken from crude oil after the more volatile portions used in gasoline are removed. The boiling points of these heavier distillates range from 350 degrees to 650 degrees Fahrenheit. Thus, their evaporation temperature is much higher than that of gasoline that has fewer carbon atoms per molecule. Specifications for diesel fuels published in 1970 listed three grades: the first was a volatile distillate recommended for high-speed engines with frequent and wide variations in load and speeds; the second, a distillate for high-speed engines in services with high loads and uniform speeds; and the third, a fuel for low- and medium-speed engines in services with sustained loads.

Water and sediment in fuels can be harmful to engine operation; clean fuel is essential to efficient injection systems. Fuels with a high carbon residue can be handled best by engines of low-speed rotation. The same applies to those with high ash and sulfur content. The cetane number, which defines the ignition quality of a fuel, is ascertained by adjusting a mixture of cetane and alpha-methyl-napthalene until it has the same ignition quality as the fuel being tested. The percentage of cetane in this mixture is then the cetane number of the fuel under test. Despite all the efforts to develop and sell high quality diesel fuel, there remains a high level of water content and other impurities within the diesel fuel.

In the operation of diesel powered trucks, automobiles, and marine vehicles, it is a common problem that excessive water will appear in the fuel and that the user of the vehicle will occasionally run out of diesel fuel. When the operator of a di sel vehicle runs out of fuel, air is suddenly injected into the fuel line and into the system. When this happens, the user must continue to operate the starter until there is a

significant chance that the starter will "burn up". Alternatively, the owner will have to call a service station or wrecker service so as to bring the car to the service station so that the fuel chamber can be properly "bled", the fuel filter primed, and the engine properly started. Under normal conditions, such a procedure is tedious and difficult to accomplish by the owner of the vehicle. Additionally, where there is a large amount of water contaminant in the fuel, the owner of the vehicle will be unlikely to take the necessary steps to remove the accumulation of water from the fuel chamber. Typically, the diesel vehicle will be disabled because of the accumulation of water in the fuel chamber. Under the circumstances, the owner of the vehicle will incur large maintenance fees and will have a diesel vehicle that is inoperable until proper repair is implemented.

It is an object of the present invention to provide a fuel filter that allows the accumulation of water to be sensed and removed by remote actuation.

It is another object of the present invention to provide a fuel filter that allows the fuel filter to be automatically primed and for air to be purged from the system.

It is another object of the present invention to provide a fuel filter and separator that reduces engine maintenance requirements.

It is still a further object of the present invention to provide a fuel filter and separator that allows the operator to restart the vehicle after running out of diesel fuel.

These and other objects and advantages of the present invention will become apparent from a reading of the attached specification and appended claims.

SUMMARY OF THE INVENTION

The present invention is a fuel filter and separator apparatus that comprises a chamber, a discharge gate, a fuel pump, and a fuel filter. The discharge gate is connected to the bottom of the chamber. The discharge gate is for the

selective discharge of contaminant fluid from the chamber. The fuel pump is connected to the top of the chamber and communicates with the interior of the chamber. The fuel pump is for causing fuel to be controlably passed into the chamber. The fuel pump, typically, is connected to the fuel line of the vehicle. The fuel filter is also connected to the top of the chamber. The fuel filter communicates with the interior of the chamber so as to permit fuel to pass from the interior of the chamber through the fuel filter. The fuel line of the vehicle is connected to one end of this fuel filter.

The chamber comprises a lid and a body. The body is r movably fastened to the lid. The fuel pump and the fuel filter are fastened to the lid. A clamp is circumferentially attached to the lid and the body so as to maintain the lid and the body in liquid-tight engagement. The body has a generally cylindrical upper portion and a narrowing lower portion. The discharge gate is fastened to the lower portion.

The discharge gate comprises a nozzle and a solenoid-actuated valve. The valve is attached in line at the nozzle so as to be disposed between the nozzle and the discharge end of the chamber. The valve is for the selective exit of fluid from the interior of the chamber. The solenoid-actuated valve has an electrical connector connected thereto. This electrical connector is for attachment to a remote switch.

The fuel pump comprises an electric pump. This electric pump has a nozzle extending outwardly from the chamber for engagement to the fuel line of the vehicle. The fuel pump further has a fuel dispersion line connected to and extending from the electric pump within the chamber. This fuel dispersion line causes fuel to pass from the electric pump into the chamber. Typically, two or four fuel dispersion lines extend outwardly in different directions within the chamber. The fuel pump further includes a fuel accumulator connected to the electric pump at the end opposite the nozzle of the pump. The electric pump passes fuel into the accumulator. The fuel

dispersion lines are connected in fluid communication with this fluid accumulator.

The fuel filter comprises a filter mounted within the chamber adjacent the top of the chamber. This filter has a plurality of openings thereabout. An exit line is in fluid communication with this filter and extends outwardly from the chamber. This exit line allows air and fuel to pass from the interior of the chamber. The exit line further includes an air purge valve connected thereto. The air purge valve permits the removal of air from the exit line.

The apparatus of the present invention further includes a water sensor mounted to the chamber so as to detect the presence of water within the chamber. This water sensor includes a first probe and a second probe. The first and second probes extend through the wall of the chamber such that one end of each of the probes extends inwardly of the wall of the chamber so as to be interactive with the fluid within the chamber. The first and second probes are arranged distal from each other such that an electric current of a certain magnitude will pass between each of the probes in the presence of water. A suitable communication line is connected to these probes so as to register a signal upon the accumulation of water within the chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is view in side elevation of the fuel filter and separator in accordance with the preferred embodiment of the present invention.

FIGURE 2 is a top view showing the configuration of the fuel filter and separator of the present invention.

FIGURE 3 is a cross-sectional view in side elevation of the fuel filter and separator in accordance with the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGURE 1, there is shown at 10 the preferred embodiment of the fuel filter and separator in accordance with the present invention. Fuel filter and separator 10 includes chamber 12, discharge gate 14, fuel pump 16, fuel filter 18, and water sensors 20. The discharge gate 14 is connected to the bottom 22 of chamber 12. The discharge gate 14 is for the selective discharge of fluid from within the chamber. The fuel pump 16 is connected to the top 24 of chamber 12. As described hereinafter, this fuel pump 16 communicates with the interior of chamber 12. The fuel filter 18 is also illustrated (in small portion) in FIGURE 1. Fuel filter 18 is connected to the top 24 of chamber 12. This fuel filter 18 communicates with the interior of the chamber, as will be described hereinafter.

The chamber 12, as described herein, is a RAYCOR (TM) filter bowl. As shown, the RAYCOR (TM) filter bowl has been modified to accommodate the arrangement of components described in FIGURE 1. Chamber 12 includes a lid 30 and a body 32. The body 32 is removably fastened to the lid. As can be seen, both the fuel pump 16 and fuel filter 18 are also attached to lid 30 of chamber 12. A hand clamp 34 is circumferentially attached to the lid 30 and to the body 32. The tightening of the hand clamp 34 causes the lid 30 to be attached to the body 32 in a liquid-tight manner. The body 32 has a generally cylindrical upper portion 36 and a tapered, gradually narrowing bottom portion 38. The discharge gate 14 is attached to this bottom portion 38.

The discharge gate 14 comprises a nozzle 40 and a solenoid-actuated valving arrangement 42. The valving arrangement 42 is arranged in-line between the discharge end 22 of chamber 12 and the nozzle 40. The solenoid-actuated valve 42 selectively causes the flow of fluid from the interior of chamber 12 through the exit nozzle 40. The solenoid-actuated valve has an electrical connector 44 operably connected thereto. The connector 44 may be electrically connected to a remote switch by way of suitable electric connections. In actual operation, this remote switch may be arrang d in the cab

of the vehicle utilizing he fuel filter and separator 10 of the present invention.

The fuel pump 16 is an electric pump. This electric pump is powered by electric lines 46 and 48 which are connected to the battery (not shown) of the vehicle utilizing the present invention. The electric pump described herein is an E12S Airtex 12-volt 8 p.s.i. pump. The fuel pump 16 has a nozzle 50 extending outwardly and upwardly from the body 52 of pump 16. Nozzle 50 is of a type suitable for connection to the fuel line of the vehicle utilizing the present invention. The remainder of the body 52 of fuel pump 16 is fastened within a collar 54 extending upwardly from the top surface 24 of the lid 30 of chamber 12. The pump 52 should maintain a secure connection within this collar 54. As will be described hereinafter, the vibration imparted by fuel pump 52 is beneficial to the proper operation of the fuel filter and separator 10 of the present invention.

In FIGURE 1, the fuel filter 18 only shows the exit line 60 mounted adjacent the top surface 24 of the lid 30 of chamber 12. This exit line 60 is configured for proper connection to the fuel line of the vehicle utilizing the present invention.

Referring to FIGURE 2, the fuel filter and separator 10 are shown from the top view. In particular, the top surface 24 of the lid 30 of the chamber 12 is illustrated. Additionally, the hand clamp 34 and its manner of circumferential connection to the chamber 12 is illustrated. The hand clamp 34 is properly beneficial whenever it is necessary to remove the internal components within the chamber 12 or otherwise to gain access to the interior of the chamber 12. The hand clamp 34 is of a type of common configuration and use in automotive applications.

The fuel pump 16 with its nozzle 50 are shown as located relative to the top surface 24. A portion of the discharg gate 14 extends outwardly beyond the outer diameter of the chamber 12.

Importantly, the configuration of the exit line 60 of fuel filter 18 is shown in detail. The exit line 16 includes connector portion 62 extending outwardly. The fuel line 64 engages this connector section 62 so as to permit fluid communication between the exit line 60 and the fuel line of the vehicle utilizing the present invention. Importantly, the air purge valve 66 is connected to the line 64. The air purge valve 66 permits the removal of air from the exit line.

FIGURE 3 shows a cross-sectional view of the interior of chamber 12 of the fuel filter and separator 10 of the present invention.

For the purposes of illustration, the discharge gate 14 has been removed. It can be seen that the bolt portion 45 (shown in FIGURE 1) engages the internal threads 70 at the discharge end 22 of chamber 12. The bolt 45 will form a liquid-tight seal with the thread 70 at this discharge end 22 with proper tightening.

Fuel pump 16 is shown engaging the collar 54. The fuel pump 16 serves to transmit fuel, under pressure, through line 72. Line 72 extends through the lid 30 of chamber 12 so as to draw fuel into the fuel accumulator 74 mounted at the bottom surface 76 of lid 30. Fuel accumulator 74 is in direct fluid communication with the fuel pump 16. As the accumulator 74 fills with fuel, the fuel will pass from the interior of accumulator 74 and into the fuel dispersion lines 78 and 80. The fuel dispersion lines 78 and 80 are in fluid communication with the accumulator 74. These dispersion lines 78 and 80 ar arranged so as to disperse the fuel into the interior of chamber 12. For proper and complete dispersion, it is important for the dispersion lines 78 and 80 to extend outwardly from the accumulator 74 in different directions within chamber 12. In operation, the fuel will pass and be dispersed and dropped as shown by 82 in FIGURE 3. The dispersion is important insofar as it will assist in the ability to separate the water from the diesel fuel 82. Since

the diesel fuel 82 is lighter than water 84, the diesel fuel will eventually be layered above the water 84.

The fuel filter 18 has a filter 86 mounted to the bottom 76 of lid 30 of chamber 12. The filter 86 has a plurality of openings 88. These openings 88 allow the fuel to slowly seep through these holes and to eventually pass from the interior filter 86 into an exit line 90 in fluid communication with filter 86. Exit line 90 extends outwardly from the chamber and is shown at 60 in FIGURES 1 and 2. This exit line allows air and fuel to pass from the interior of the chamber. Since fuel is being introduced by the fuel pump 16 under pressure into the interior of chamber 12, this pressure will cause the diesel fuel 82 to eventually rise to the level of the filter and be transmitted through the filter outwardly through line 90 and into the engine of the vehicle utilizing the present invention.

It is important to realize that the illustration of FIGURE 3 is not in proper condition for the operation of a diesel vehicle. Ultimately, the level of the diesel fuel 82 must rise to the level of the bottom surface 76 of lid 30. The pressur generated by the electric pump 16 which will cause the diesel fuel to pass into the filter and outwardly through the exit line 90 rather than to remain within the chamber 12. Eventually, the water component of the diesel fuel 82 will accumulate toward the discharge end 22 of chamber 12.

As can be seen in FIGURES 1 and 3, a water sensor 20 is mounted to chamber 12 for the purpose of detecting the presence of water within the chamber. Water sensor 20 includes a first probe 92 and a second probe 94. The first probe 92 extends through the wall of the chamber such that one end 96 of the first probe 92 extends inwardly of the wall of chamber 12. Similarly, the end of the second probe 94 will also extend inwardly of the wall of the chamber 12. The first probe 92 and the second probe 94 are distal of each other such that an electric current of a certain magnitude will pass between the first probe 92 and the second probe 94 in the presence of

water. These probes detect the pres nce of water by the conductivity of the water.

The ends of the water sensors 20 extend outwardly from the wall of chamber 12 are suitable for connection to proper lectrical circuitry. The electronics of the water sensor are readily available technology. However, for the proper operation of the present invention, the electronics of the water detection circuitry will extend from the outward end of sensors 20 so as to register a display within the cab of the vehicle utilizing the present invention. A warning light, or other display, will signal the operator of the vehicle that the water level 84 has reached the level of the probes 92 and 94. At that time, such a signal will inform the driver that it is necessary to discharge the water from the chamber 12 so as to assure the continued proper performance of the engine. Ideally, the water sensors 20 will be placed at the one-half quart mark on the chamber 12. However, the water sensors may be placed elsewhere depending on the particular needs of the system utilizing the present invention.

In operation, the present invention enhances the ability to remove the water from the diesel chamber 12 and assist in the ability of removing air from the same chamber. Initially, the chamber 12 is filled with diesel fuel to the level of the bottom surface 76 of lid 30 of chamber 12. In such a configuration, the diesel fuel 82 passes normally through the openings 88 in the fuel filter 18. The continued pressurization by the electric fuel pump 16 causes fuel to be continuously passed into the engine for internal combustion and the continued operation of the vehicle.

In normal operation, diesel fuel may contain a large amount of water. In marine applications, the presence of water tends to be even greater. It is a major concern of the operators of such engines that water not enter the combustion chamber and that water be properly filtered from the syst m. The pres nt invention operates on the fact that the water 84 has a greater density than the fu l 82. Typically, the water

and fuel will be mixed as it is passed by the fuel pump 16 into the chamber 12. The present invention serves to eliminate many of the problems caused by the entering of water into the internal combustion system of the vehicle utilizing the present invention. The fuel dispersion lines 78 and 80 cause the fuel/water mixture to pass into the interior of chamber 12. Over time, the water 84 will gradually drift to the discharge area 22 of chamber 12. The present invention enhances this layering of the fuel/water interface by the use of the dispersion lines 78 and 80 and by the vibration caused by the lectric fuel pump 16. After experimentation, it has been found that the vibration helps to settle and separate the diesel fuel 82 from the water 84. The multiple dispersion lines also help to settle and separate the water from the fuel.

Eventually, the level of the water 84 will rise so as to occupy a greater amount of the volume of chamber 12. When the water level reaches the level of the water sensors 20, the water sensors will signal an alarm or a display within the cab of the vehicle utilizing the present invention. This will signal the operator of the vehicle to take the necessary steps to remove the buildup of water in chamber 12.

The operator of the vehicle is able to remove the water by activating the solenoid-actuated discharge valve 14 so as to allow the water 84 to pass from the interior of chamber 12 outwardly through nozzle 40. This discharge should continue until the signal produced by the water sensors 20 is eliminated. This will provide the driver with the necessary information that the water has been dispersed from the interior of the chamber 12. The solenoid-actuated valve 14 is actuated by the proper switching mechanism connected to electrical connector 42. The water may be dispersed toward the ground beneath the vehicle or into a separate container attached to nozzle 40. During the dispersion of the water, it is necessary to continue to operate the electric pump 16 so as to continue to maintain the high level of diesel fuel 82 within chamber 12. Since the fuel pump 16 is electric, it is possible to continue

to fill the chamber 12 without continuing to operate the internal combustion engine.

When air develops above the level of the fuel 82 within chamber 12, it is necessary to purge the air from the system. This is accomplished by continuing to operate the electric pump 16 so as to draw the air through the openings 88 of the fuel filter 18. The air is purged from the system by the proper actuation of the air purge valve 66 attached to fuel line 64.

The present invention achieves a number of advantages not found in the prior art. The present invention offers a simplified method and apparatus for the purging of water and air from the diesel fuel system. In the past, when the operator of diesel fuel vehicles ran out of fuel, the chamber 12 was free of fuel. At such time, it was necessary to take the vehicle to a mechanic so that the mechanic could properly prime the filter 86 and purge the air from the system. This is a rather complicated and expensive procedure. Additionally, when water builds up in the chamber 12, water would either have to be manually removed by a mechanic or water would pass into the combustion system of the diesel engine. Neither of these was a desirable alternative.

The present invention achieves its advantage by being able to remotely purge the chamber 12 of water buildup at the bottom of chamber 12. This can be accomplished remotely without the buildup of air in the chamber. Since the electric fuel pump allows the operator to continue to pump fuel into the chamber 12 while the water purging occurs, it is not necessary to conduct an air purge at the same time.

In the instance where the chamber 12 is emptied of fuel, the electric fuel pump 16 allows the operator to fill the chamber 12 so as to properly prime the filter 86 prior to operation. The air purge valve 66 allows the operator to remove air from the system. It is no longer necessary for the operator to burn up the starter of his engine so as to accomplish the sam purpos s. After experimentation, it has

been found that the electric pump 16 would serve to take 98% of the load off of the starter in such a situation.

The foregoing disclosure and description is illustrative and explanatory thereof, and various changes in the details of the illustrated apparatus may be made within the scope of the appended claims without departing from the true spirit of the invention. The present invention should only be limited by the following claims and their legal equivalents.

CLAIMS

I CLAIM:

1. An apparatus comprising:

a chamber;

a discharge gate means connected to the bottom of said chamber, said discharge gate means for the selective discharge of a fluid from within said chamber;

fuel pump means connected to the top of said chamber and communicating with the interior of said chamber, said fuel means for causing fuel to controlably pass into said chamber; and

fuel filter means connected to the top of said chamber, said fuel filter means for communicating with the interior of said chamber so as to permit fuel to pass from the interior of said chamber.

2. The apparatus of Claim 1, said chamber comprising:

a lid; and

a body removably fastened to said lid, said fuel pump means and said fuel filter means fastened to said lid.

3. The apparatus of Claim 2, said chamber further comprising:

a clamp circumferentially attached to said lid and said body, said clamp for causing said lid to be attached to said body in a liquid-tight manner.

4. The apparatus of Claim 2, said body having a generally cylindrical upper portion and a narrowing lower portion, said discharge gate fastened to said lower portion.

5. The apparatus of Claim 1, said discharge gate comprising:

a nozzle; and

a solenoid-actuated valve attached in line of said nozzle, said nozzle and said valve for the selected exit of fluid from the interior of said chamber.

6. The apparatus of Claim 5, said solenoid-actuated valve having an electrical connected thereto, said electrical connector for attachment to a remote switch.

7. The apparatus of Claim 1, said fuel pump means comprising an electric pump, said electric pump having a nozzle extending outwardly from said chamber for connection to a fuel line.

8. The apparatus of Claim 7, said fuel pump means further comprising:

a fuel dispersion line connected to and extending from said electric pump within said chamber, said fuel dispersion line for causing fuel to pass from said electric pump into said chamber.

9. The apparatus of Claim 8, said fuel pump means further comprising:

at least a pair of fuel dispersion lines extending outwardly in different directions within said chamber.

10. The apparatus of Claim 8, said fuel pump means further comprising:

a fuel accumulator connected to said electric pump on the end opposite said nozzle such that said electric pump passes fuel into said fuel accumulator, said fuel dispersion line being connected in fluid communication with said fuel accumulator.

11. The apparatus of Claim 1, said fuel filter means comprising:

a filter mounted within said chamber adjacent the top of said chamber, said filter having a plurality of openings thereabout; and

an exit line in fluid communication with said filter and extending outwardly from said chamber, said exit line for allowing air and fuel to pass from the interior of said chamber.

12. The apparatus of Claim 11, said exit line comprising:

an air purge valve connected thereto, said air purge valve for permitting the removal of air from said exit line.

13. The apparatus of Claim 1, further comprising:

a water sensor means mounted to said chamber so as to detect the presence of water within said chamber.

14. The apparatus of Claim 13, said water sensor means comprising:

a first probe extending through a wall of said chamber such that one end of said first probe extends inwardly at the wall of said chamber; and

a second probe extending through a wall of said chamber distal of said first probe, said second probe extending inwardly of the wall of said chamber, said first and second probes arranged such that an electrical current of a certain magnitude will pass between said first and second probes in the presence of water.

15. An apparatus comprising:

a chamber having an upper surface and a discharge end, said chamber in fluid communication with the fuel line of an internal combustion engine;

discharge gate means connected to said discharge end of said chamber, said discharge gate means for the selective discharge of fluid from within said chamber; and

water sensor means connected to said chamber so as to be interactive with fluid within said chamber, said water sensor means for the detection of water within said chamber.

16. The apparatus of Claim 15, said discharge means comprising:

an exit nozzle; and

a solenoid-actuated valve attached in line between said discharge end of said chamber and said exit nozzle, said solenoid-actuated valve movable between an opened and closed position, said valve being remotely actuable for the discharge of water from within said chamber.

17. The apparatus of Claim 15, further comprising:

fuel pump means connected to the top surface of said chamber and communicating with the interior of said chamber, said fuel pump means connected to the fuel line of an internal combustion engine, said fuel pump means being an electric pump.

18. The apparatus of Claim 15, further comprising:

fuel filter means connected to the top surface of said chamber, said fuel filter means for communicating with th interior of said chamber so as to permit fuel to pass from the interior of said chamber into the fuel line of an internal combustion engine.

FIG. 1

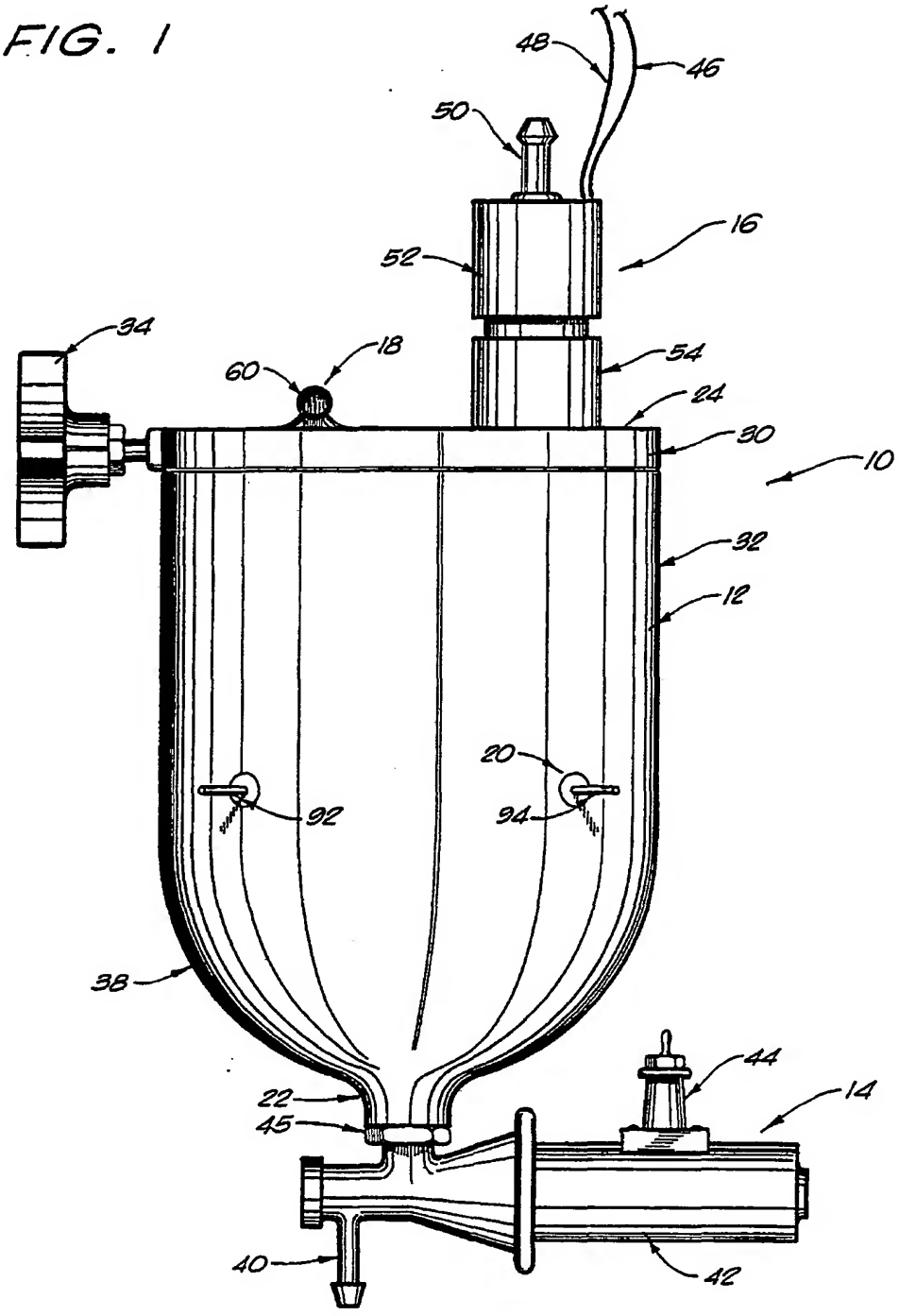


FIG. 2

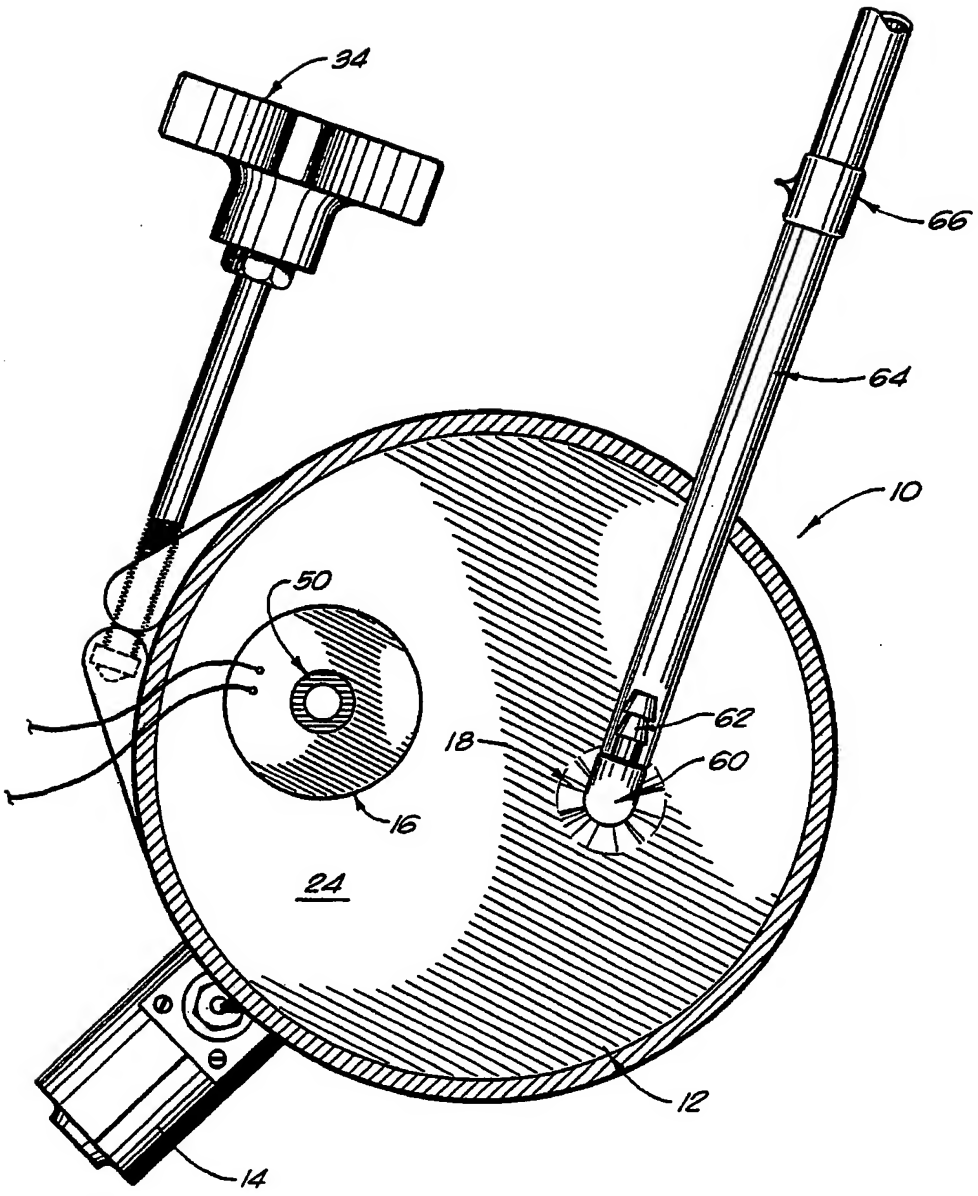
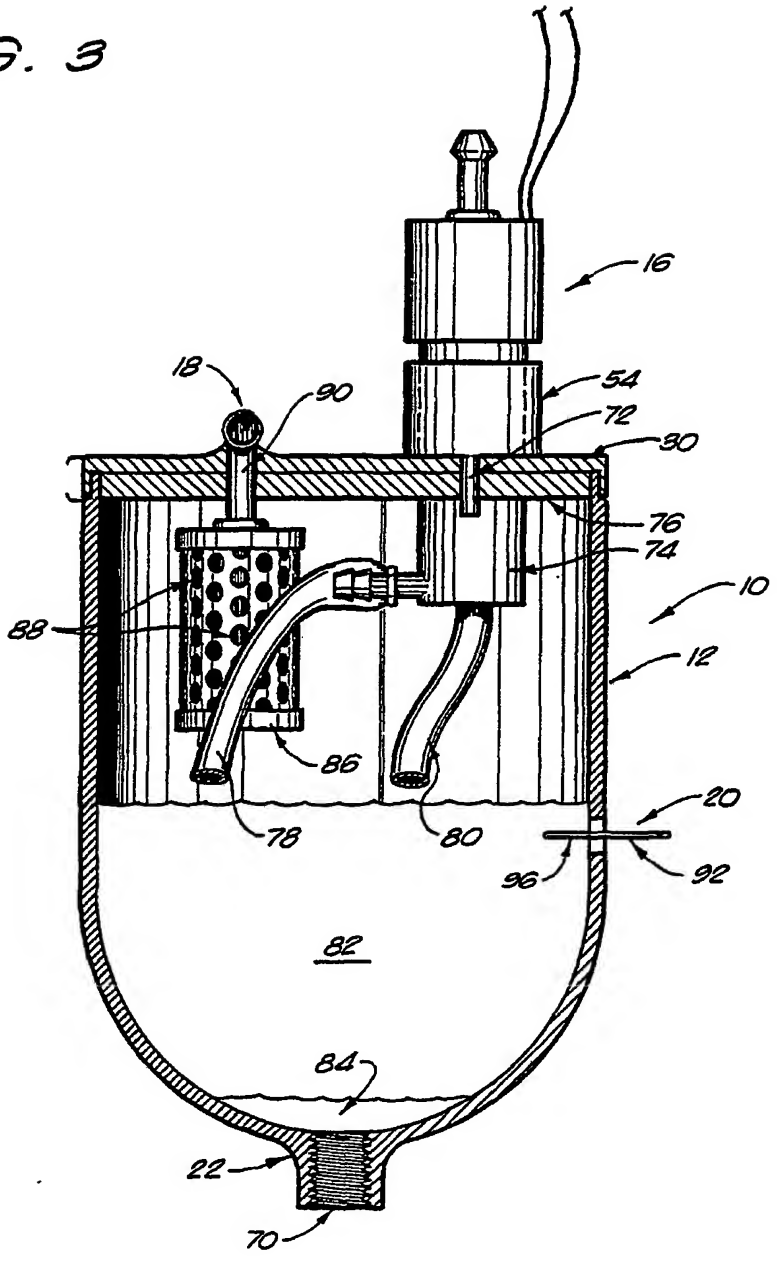


FIG. 3



INTERNATIONAL SEARCH REPORT

International Application No. PCT/US88/04503

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(4): B01D 23/20, 29/42, 35/00, 35/26

U.S.CL.: 210/86, 112, 114, 313, 416.4, 519, 533

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	210/86, 112, 114, 306, 311, 312, 313, 416.4, 456, 519, 533, 534, 535, 537

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	US, A, 4,637,351 (PAKULA) 20 JANUARY 1987 SEE THE ENTIRE DOCUMENT.	15, 16 1-14, 17,18
Y	US, A, 4,554,074 (BROUGHTON) 19 NOVEMBER 1985. SEE COL. 3, LINES 31-46.	8-10
X	US, A, 4,539,109 (DAVIS) 03 SEPTEMBER 1985 SEE COL. 4, LINES 9-22 AND COL. 6, LINES 9-34.	15-17
Y	US, A, 4,437,986 (HUTCHINS) 20 MARCH 1984 SEE COL. 3, lines 42-49.	12
Y	US, A, 4,321,136 (MATSUI) 23 MARCH 1982 SEE COL. 2, LINES 13-40 AND COL. 3, LINES 9-41.	1-14, 17, 18
Y	US, A, 4,224,157 (JAIN) 23 SEPTEMBER 1980 SEE COL. 5, LINES 5-16.	8-10
Y	US, A, 2,503,566 (SCOTT) 11 APRIL 1950 SEE COL. 3, LINES 13-36.	8-10

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search

27 February 1989

Date of Mailing of this International Search Report

03 APR 1989

International Searching Authority

ISA/US

Signature of Authorized Officer

Andrew J. Anderson

Form PCT/ISA/210 (second sheet) (Rev.11-87)